

Article

Stepping up Open Science Training for European Research

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Abstract: Open science refers to all things open in research and scholarly communication: from publications and research data to code, models and methods as well as quality evaluation based on open peer review. However, getting started with implementing open science might not be as straightforward for all stakeholders. For example, what do research funders expect in terms of open access to publications and/or research data? Where and how to publish research data? How to ensure that research results are reproducible? These are all legitimate questions and, in particular, early career researchers may benefit from additional guidance and training. In this paper we review the activities of the European-funded FOSTER project which organized and supported a wide range of targeted trainings for open science, based on face-to-face events and on a growing suite of e-learning courses. This article reviews the approach and experiences gained from the first two years of the project.

Keywords: open science; open access; training; policies; European research

1. Introduction

Open science holds the promise that access to research results, transparency of research processes and quality assessment benefits scientific progress and innovation. “Open science is the movement to make scientific research, data and dissemination accessible to all levels of an inquiring society, amateur or professional. It encompasses practices such as publishing open research, campaigning for open access, encouraging scientists to practice open notebook science, and generally making it easier to publish and communicate scientific knowledge” [1]. The term ‘open science’ was originally introduced to describe aspects of openness which emerged in the late 16th and early 17th centuries, in particular “norms concerning the sharing of knowledge in regard to new findings and the methods whereby they were obtained” [2]. Today’s use of the term builds on these values, and merges the various strands of open initiatives (e.g., [3–6]). FOSTER follows these definitions and emphasises the aim that open science enables others to “collaborate and contribute, where research data, lab notes and other research processes are freely available, under terms that enable reuse, redistribution and reproduction of the research and its underlying data and method” [7].

The concept is gradually reaching the agenda of policy makers and research funders, which move on to include open science-related topics from open access to publications and research data,

citizen science, evidence-based policy making, alternative research metrics and e-infrastructures for open science (e.g., [8–10]). Although open science practices itself are typically invented by the research community itself, funder (and to some degree institutional) policies play a significant role in providing a common framework (while taking into account disciplinary differences) as well as infrastructure and services which support the policies' implementation (regarding dependencies cf. [11]). In addition, advocacy and training activities are instrumental to further these principles and practices.

Therefore, the intention of the FOSTER project (acronym for: Facilitating Open Science Training for European Research) is to facilitate the integration of open science into the workflows of European researchers. As the largest research funder in the European Research Area, the European Commission has set in place several open science policies and mandates in its framework programmes. Launched in August 2008, the Open Access pilot in the Seventh Framework Programme (FP7, 2007–2013) has evolved into an Open Access mandate in the follow-up research and innovation programme Horizon 2020 (2014–2020), combined with a voluntary Open Data Pilot [12]. In support of the implementation of these policies, the FOSTER project has established four main objectives:

- Support different stakeholders, especially young researchers, in adopting open access in the context of the European Research Area (ERA) and in complying with the open access policies and rules of participation set out for Horizon 2020;
- Integrate open access principles and practice in the current research workflow by targeting the young researcher training environment;
- Strengthen the institutional training capacity to foster compliance with the open access policies of the ERA and Horizon 2020 (beyond the FOSTER project);
- Facilitate the adoption, reinforcement and implementation of open access policies from other European funders, in line with the EC's recommendation, in partnership with the PASTEUR4OA project [13].

These objectives were pursued through the combination of three main activities. First of all, the creation of the FOSTER portal to support e-learning, self-learning, dissemination of training materials/contents and a helpdesk. Moreover, training materials are essential for open science training. Therefore, the identification of already existing contents that can be reused in the context of the training activities and repackaging is supported, reformatting them to be used within FOSTER and to be found on the FOSTER portal, and develop/create/enhance contents if/where they are needed. Last but not least, FOSTER supports the delivery of face-to-face training, especially training trainers/multipliers that can carry on further training and dissemination activities, within their institutions, countries or disciplinary communities.

2. A Home for Open Science Training: The FOSTER Portal

The FOSTER portal [14] is an e-learning platform that brings together quality training resources for those who need to know more about open science, or who need to develop strategies and skills for implementing open science practices in their daily workflows. It brings together a growing collection of training materials to meet the needs of many different users, from early-career researchers, to data managers, librarians, funders, and graduate schools.

2.1. Learning Resources

At the start of the project, a scoping exercise and call to the open access and more generally open science community was used to gather a collection of existing training resources. The topics of these resources were analysed to understand how to logically organise the content for presentation purposes. This resulted in the development of the *Open Science Taxonomy* (cf. Figure 1) [15,16] which was used as a structure according to which all materials were classified. In addition, event organisers were asked to upload presentations given during training sessions. These materials are openly licensed by default,

preferably under a Creative Commons CC BY 4.0 license, or put in the public domain using Creative Commons CC0. In addition, the portal links training materials to each other and to events where they were presented.

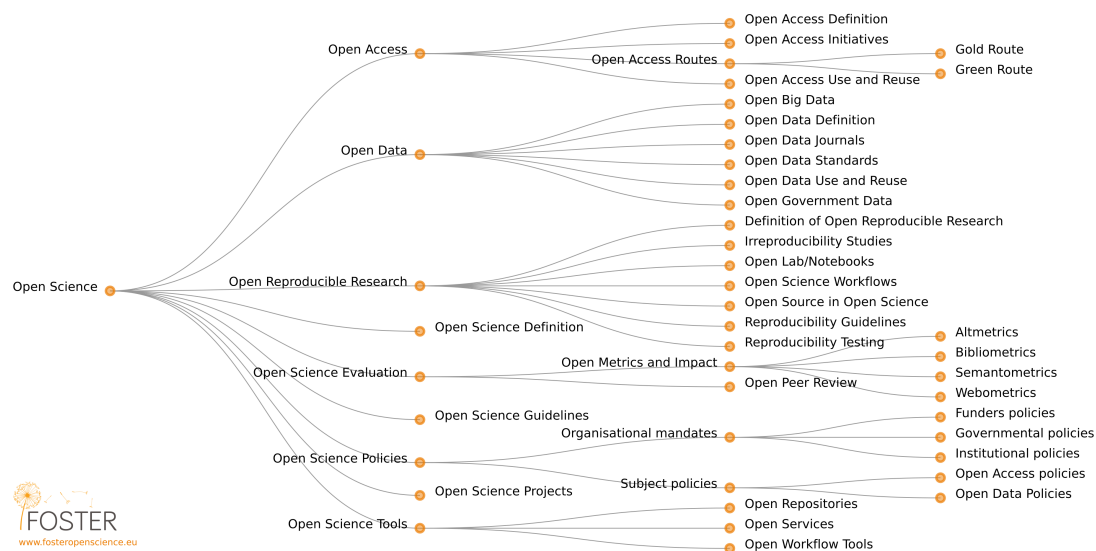


Figure 1. Open Science Taxonomy.

As all materials are classified based on the taxonomy, this tool also highlights which areas are well-represented and where are gaps (*cf.* Figure 2). Overall, the open science subset splits into 35% on open access, 30% on open data, 17% on open science policies but only 8% on open science tools and 3% each on open reproducible research and open science evaluation. In particular, it seems to be difficult to identify guidelines on reproducibility and materials on reproducibility testing. Further areas which are covered by the FOSTER collection are research data management, ethics and legal issues.

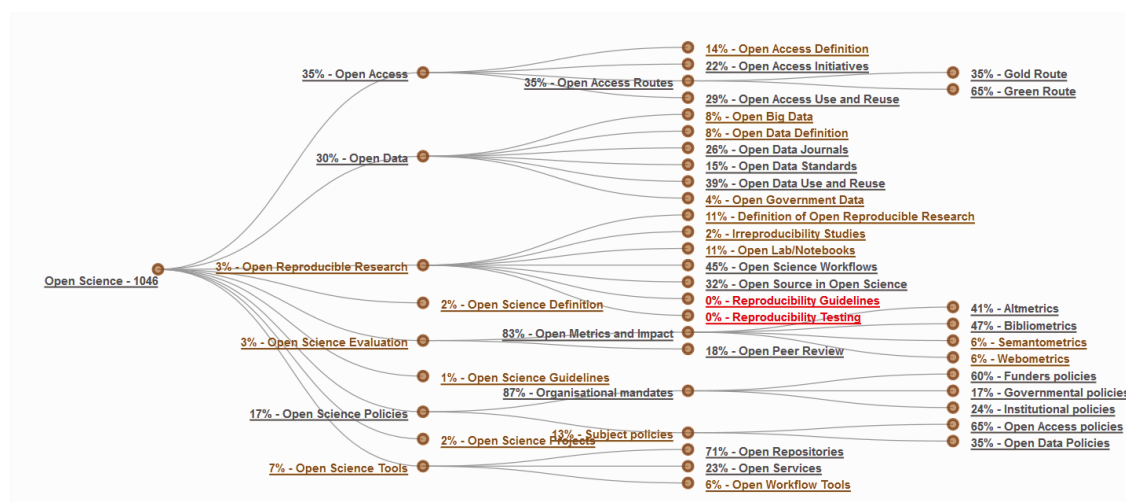


Figure 2. Open science taxonomy showing the distribution of topics.

For more specialized questions the taxonomy can serve as a starting point for further exploration. For example, a society publisher seeking information about open data journals will find a range of examples as well as pointers to relevant resources (e.g., data management and sharing in general, guidance on data citation and data licensing, a survey on data journals) [17,18]. Similarly, researchers who wish to disseminate their research results via open access channels

are offered generic and disciplinary guidance on how to practice open dissemination and open science (e.g., presentations/videos/materials on benefits for researchers, green/gold routes, funder requirements, publisher policies, *etc.*) [19–21].

2.2. Development of the Portal

The main idea influencing the development of the FOSTER portal was to create a virtual space where people can explore what open science is without any prior knowledge of the subject. As it is typically hard for users to compose queries about topics they are not familiar with [22], our development effort focused on making navigation and browsing on the portal as seamless and engaging as possible.

The open science taxonomy serves as a backbone for the navigation capabilities. It allows users to explore the topics and to gradually familiarise themselves with open science. The taxonomy has been integrated with the portal:

- As a navigation and classification system for training resources, events and online courses;
- As a visualisation tool to inform users about open science themes for which training materials are available;
- To power a new content notification system to which users can subscribe to.

Additionally, the browsing capabilities are enhanced by a content recommendation system which helps users to discover related training resources to the one currently viewed in FOSTER and in the open access aggregator CORE [23].

The portal offers the capabilities for uploading textual didactic content, such as presentations, articles or books, as well as multimedia content, such as videos. While the materials were originally uploaded by the consortium, the portal provides the necessary support for accepting/approving new crowd-sourced training materials. Anyone can subscribe to become a content provider and upload content to FOSTER. Newly uploaded content becomes immediately available but also triggers notifications to reviewers familiar with the specific topic to approve it.

Finally, the portal also provides tools for creating and serving free e-learning courses. These might include interactive materials, such as quizzes. Once a user subscribes to a course, the portal tracks their progress and provides a learning analytics module offering feedback to the course creators.

3. FOSTER Training Events

During the course of the FOSTER project, two calls for open science trainings were issued. The first call resulted in the approval of 17 training events (out of 45 proposals) from 13 countries. These 17 training proposals involved a total of 66 initiatives, as some of them were a series of courses. In the second call, FOSTER approved 24 training sessions in 18 different countries (out of 79 proposals), resulting in 39 events organised during 2015. In total, the FOSTER training programme will have reached more than 4600 researchers, students, PhD students, project managers, publishers, policy makers, funders, librarians and repository managers. Several training events continue into 2016 as a result of the ‘train the trainer’ effect—event organisers and participants are following up the original trainings with extra sessions, webinars and publications. An overview of all FOSTER events can be found at [24].

The FOSTER trainings have covered a wide range of topics, from very generalistic ‘open science’, ‘open access’, ‘policy’, ‘open data’, ‘research data management’ trainings to workshops targeted at specific audiences, e.g., medical students [25], humanities PhD students [26], geoscience researchers [27], or on very specific subjects, e.g., ethical issues, open software [28], intellectual property rights, open workflows [29]. The majority of events was targeted at researchers and (PhD) students [30,31], but a significant number of trainings was specifically aimed at supporting staff such as librarians, repository managers and project coordinators [32]. A third audience group were funders, research administrators and policy makers [33–35]. A small number of events also

targeted publishers. Nearly two third of trainees were female (64%) and more than one third (36%) male participants.

Organisers made use of the FOSTER speaker directory [36] and got frequently in touch with (local) representatives of the FOSTER project—asking for speaker suggestions and recommendations. This allowed for outreach to related initiatives and networks such as Creative Commons, Open Knowledge, SPARC and EURODOC, and increased the name recognition of the FOSTER project amongst different stakeholders [37–40]. This approach also allowed for trainings to be given in other languages than English, a feature that was valued highly amongst audiences. Trainings took place in 24 countries throughout Europe.

In general, participants ranked the quality of the trainings between ‘good’ and ‘excellent’. According to the evaluation forms, attendants highly valued the quality of speakers and training materials provided, and appreciated the wide range of topics that were discussed during the majority of trainings. However, this proved to be the biggest weaknesses of many events: in some cases the remark was made that the audience would have preferred a more in-depth training session focusing on a smaller amount of topics. Other evaluations mentioned the lack of time for group discussions. Event organisers have indicated that they would follow up these remarks in the coming years, with follow-up trainings and/or communications. Globally, the comments and evaluations prove that there is no ‘one size fits all’ approach for open science training, and they are an indication that the FOSTER approach has tackled this quite well: as local trainers were able to identify and target subjects and audiences, the FOSTER events allowed for a tailor-made approach.

The feedback received by the project from local organisers was very positive. The organisers appreciated the flexibility of cost allocation and the general support received from FOSTER, as well as the infrastructure provided for the hosting of event pages and training materials. Main points of complaint were related to the relatively heavy administrative burden (especially when the amounts requested were low) and to some technical issues with the FOSTER portal and website.

4. Piloting e-Learning Courses for Open Science

Considering the geographical scope of the project, e-learning courses are a more appropriate method to reach out to different stakeholders from a wide range of countries with reduced costs, enabling a cost-efficient approach for training and learning open science topics.

The strategy for e-learning on the FOSTER portal is based on two different types of courses: moderated courses and self-learning courses. The FOSTER portal acts as a Learning Content Management System (LCMS) which supports the management of content (text, videos, web pages, *etc.*) and allows the creation of e-learning courses based on existing contents on the portal.

Self-learning courses allow anyone to register for a course and finish it in a self-managed manner, *i.e.*, within the time s/he needs to accomplish all the proposed or selected activities. The timespan of the course depends on the end-user and is flexible. Moderated courses are defined in terms of timing and have a specific schedule where a moderator, that in this case is a specialist on the topic, will go along with trainees, and offers webinars, Skype calls and moderates the course forum.

The portal allows a set of activities to be configured on the courses like quizzes, which supports the evaluation of trainees or if requested a final certificate. In addition, a specific module allows to create interactive content like “fill in the blank”, “drag and drop”, a chat or even a Twitter user feed.

Some of the courses developed by FOSTER have been translated into Spanish, French, Portuguese and Polish to facilitate the local implementation of courses and also to reach learners in different regions of the world.

Currently further courses are under development or under revision. Moreover, workshops at events (e.g., at the LIBER2016 conference [41]) will be used to demonstrate the functionalities of the FOSTER portal and in order to encourage the open science community to create and/or enhance e-learning courses.

5. Discussion

Conceptually, FOSTER takes a broad and horizontal approach compared with other training initiatives, as it basically targets all open science topics but allows for specialization based on the co-funding of community-driven events. This has resulted in a good coverage of diverse stakeholders and audiences (compare [42]).

Other initiatives contribute further opportunities for the development of open science skills and competencies as well, and some implement a train-the-trainers approach, while typically with a more specialized focus: e.g., Open Knowledge's School of Data, several online courses/MOOCs addressing data literacy and Data Science topics (some also cover reproducible research principles and tools), face-to-face workshops and online courses on research data management (e.g., MANTRA, which currently inspired the creation of a MOOC), software and data training (e.g., Data and Software Carpentry) [43–46]. In addition, there are competencies and skills as well as curricula initiatives such as the joint COAR/LIBER/ARL/CARL Task Force targeting the library community, UNESCO's open access curriculum, and the EU-funded EDISON project which addresses data science professionals and data science curricula [47–49].

Infrastructure initiatives are also stepping up their training activities. This covers horizontal initiatives such as OpenAIRE and EUDAT (with both, there is overlap in terms of FOSTER partners), as well as targeted international alliances such as the Research Data Alliance (RDA) [50–52], and increasingly trainings are offered by disciplinary initiatives and infrastructures (e.g., CESSDA for the social sciences, DARIAH-EU for the digital humanities, ELIXIR for the biosciences [53–55]).

On the institutional level, there are some initiatives but so far only a few graduate schools (e.g., Kaunas Technical University, Lithuania; Tartu University, Estonia) cover open science topics systematically. However, FOSTER's training calls certainly encouraged additional institutions to set up or further develop such trainings.

Last but not least, open science topics are not constrained to research but can also be applied to innovation processes. In Horizon 2020, Responsible Research and Innovation (RRI) was introduced as a cross-cutting issue, covering aspects of the relationship between science and innovation and society: public engagement, open access, gender equality, science education, ethics and governance [56]. Several projects address the principles as well as implementation and training aspects of RRI (e.g., RRITools, HEIRRI [57,58]).

All these initiatives contribute to a refined understanding of training and education needs in the open science realm. However, additional efforts are needed to facilitate the interlinking of these initiatives, the evaluation of training outcomes and how trainings about these topics can be further improved and better embedded into the education of researchers, practitioners and citizens.

6. Conclusions

During the FOSTER project a wide range of training efforts has been mobilized and been made more visible and reusable through the FOSTER portal. Based on the experiences of the last two years the following recommendations regarding training for open science can be made:

- Open science skills can and should be integrated into graduate school programmes; coordination and combination with research integrity training is highly recommended [59].
- Training efforts should be part of every data-related and e-infrastructure project or initiative, and be made visible and materials be shared through training portals such as FOSTER. Over time, a network of dedicated repositories and training hubs can emerge.
- Enable further community-driven trainings; co-funding and co-branding in European-funded contexts provide strong incentives and additional visibility.
- The train the trainers approach should be expanded, with the aim to strengthen training capacities as well as to facilitate a network of trainers across sub-topics of open science, with both generic and disciplinary specializations.

- For the resources and functionalities made available by FOSTER, further exploitation and extension of the knowledge base would be most desirable.

For all publicly funded projects securing sustainability remains a challenge, and is often solved by continuing operation of basic services for a limited number of years and assessing how these could be integrated into existing infrastructures. In the remaining months of the project the FOSTER partners will discuss these options and seek to agree on a sustainability strategy.

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Abbreviations

The following abbreviations are used in this manuscript:

ARL: Association of Research Libraries
 CARL: Canadian Association of Research Libraries
 CESSDA: Consortium of European Social Science Data Archives
 COAR: Confederation of Open Access Repositories
 CORE: Connecting REpositories
 DARIAH-EU: Digital Research Infrastructure for the Arts and Humanities
 EDISON: Building the Data Science Profession
 ELIXIR: A distributed infrastructure for life-science information
 EUDAT: The European Data Infrastructure
 euroCRIS: Current Research Information Systems
 EURODOC: EURODOC The European Council of Doctoral Candidates and Junior Researchers
 FOSTER: Facilitate Open Science Training for European Research
 HEIRRI: Higher Education Institutions and Responsible Research and Innovation
 LIBER: Ligue des Bibliothèques Européennes de Recherche—Association of European Research Libraries
 MOOC: Massive Open Online Course
 PASTEUR4OA: Open Access Policy Alignment Strategies for European Union Research
 OpenAIRE: Open Access Infrastructure for Research in Europe
 RRItools: Responsible Research and Innovation Toolkit
 SPARC: Scholarly Publishing and Academic Resources Coalition
 UNESCO: United Nations Educational, Scientific and Cultural Organization

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